

SSPC: The Society for Protective Coatings

TECHNOLOGY UPDATE NO. 1

Surface Tolerant Coatings for Steel

1. Scope

This document defines surface-tolerant coatings and discusses their uses and limitations. It is widely recognized that the application of protective coatings over improperly prepared surfaces is poor painting practice. It is also recognized that proper surface preparation is not always possible or feasible and that the use of surface-tolerant coatings may offer an economical compromise. The types of coatings for specific end uses are dependent on the condition of the substrate. This technology update is for general information purposes only.

2. Description and Use

Surface-tolerant coatings may be defined as coatings for substrates that have been prepared for painting to a lesser degree of cleanliness than provided by SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."¹ Surface-tolerant coatings exhibit a greater propensity toward satisfactory service performance than conventional coatings not intended for such applications.

Section 3 is subdivided into narratives for surface-tolerant coating usage, compromised steel substrates, and surface-tolerant coating technologies and their limitations.

3. Discussion

3.1 SURFACE-TOLERANT COATING USAGE: Surface-tolerant coatings may be selected for many reasons. They are chosen for jobs where less-than-ideal surface cleanliness can be achieved, such as areas where abrasive blasting cannot be performed. Surface-tolerant coatings may be specified for overcoating existing aged coatings. In some instances, this has been done to cover and extend the service life of lead-based paint systems. Due to its geographical location and function, steel may become contaminated with deposits that are difficult to remove. For example, deicing and marine salt deposits may remain on steel even after abrasive blast cleaning.

Sometimes surface-tolerant coatings are specified to reduce overall painting costs by lowering the surface preparation requirements. Although the use of surface tolerant coatings over minimally prepared surfaces will generally reduce performance compared to thoroughly prepared and coated surfaces, proper selection and use of these systems may result in only modest performance reductions. Certain environmental conditions may suggest the need for a surface-tolerant coating. Moisture may be readily deposited on surfaces due to fog, cold wall condensation, and seepage.

Painting under these conditions is not recommended, but in some cases may be unavoidable.

SSPC members were surveyed as to the importance of surface-tolerant coatings for various industries. Most industries indicated significant use, with the highest importance noted for bridge, petrochemical, pulp and paper, and utility facilities. Respondents indicated that rust, existing coatings, and soluble salts were the three most frequent applications of surface-tolerant coatings.

3.2 COMPROMISED STEEL SUBSTRATES: Surface-tolerant coatings are used on many types of compromised substrates including surfaces with soluble salt, petroleum product, and moisture deposits. Corrosion products and aged coatings are the most common forms of compromised surfaces. Oftentimes multiple contaminants are present. Bridges may have salt deposits, as well as corrosion products, and an existing coating. Petroleum storage facilities may have rusty painted surfaces with oily deposits. Corroded surfaces in industrial atmospheres may be contaminated with ferrous sulfate. Sulfate and chloride deposits are often the limiting factor when painting corroded steel. High concentrations of these contaminants will cause most coatings to fail (See Section 3.4).

3.3 SURFACE-TOLERANT COATING TECHNOLOGIES: Surface-tolerant coatings may be subdivided into two broad categories: corrosion inhibitive and barrier coatings. Inhibitive coatings are primarily oil-based, alkyd, and water borne acrylic coatings. A wide variety of rust-inhibitive pigments are commercially available. Various mechanisms of corrosion inhibition are postulated for these pigments. Low viscosity in these formulations improves the penetration and encapsulation of corrosion products. Corrosion-inhibitive surface-tolerant coatings are primarily used over existing coatings, corrosion products, and soluble salt contaminants. Some oil and alkyd coatings may be oil tolerant. The performance of inhibitive surface-tolerant coatings is enhanced by the addition of a barrier topcoat.

Barrier coatings work by impeding the transmission of water vapor, oxygen, and ions to the substrate/coating interface.^{2,3} Both the binder and the pigmentation are important in achieving good barrier properties. Two-component epoxies and urethanes have excellent barrier properties when properly formulated. Lamellar pigments such as aluminum flake, mica, glass flake, and micaceous iron oxide can further improve the performance of surface tolerant coatings by enhancing their barrier properties. Two common surface-tolerant barrier-type coatings that use lamellar pigments are epoxy mastics and moisture-cure urethanes.

Barrier coatings are most commonly used over rust, existing coatings, and soluble salt contaminants. Specialized barrier coatings are sometimes used on moist and oily surfaces. Some epoxies are formulated such that small amounts of oil may be absorbed into the coating without seriously impairing performance.⁴ Some urethane coatings may be especially tolerant of surface moisture.

Other types of surface-tolerant coatings include penetrating primers, tape coatings, and rust convertors. Penetrating primers are typically unpigmented, low-viscosity, two-component epoxies or urethanes that are used in conjunction with barrier-type topcoats. Tape coatings provide a barrier to moisture and oxygen migration and may also contain corrosion inhibitors. They are typically hand applied with the most common application being corroded piping systems. Rust convertors typically consist of a conversion chemical such as tannic acid combined with an acid-tolerant binder such as a vinyl-type emulsion.⁵ The acid component stabilizes the corrosion products and the binder forms a film. Rust convertors are usually topcoated with a barrier coating.

3.4 LIMITATIONS OF SURFACE-TOLERANT

COATINGS: The performance limitations of surface-tolerant coatings are not always well recognized within the industry. Premature failures attributed to surface-tolerant coatings are more often the result of unrealistic expectations. High levels of surface contaminants, incompatible or poorly adherent aged coatings, and severe exposure environments all contribute to early coating failure. State-of-the-art characteristics of surface-tolerant coatings indicate that most are compatible with specific contaminants and are not necessarily tolerant to a combination of contaminants.

Excessively high concentrations of soluble salts can result in premature coating failure. Research has shown that concentrations greater than 500 mg/m² of chloride or 1000 mg/m² of sulfate are associated with blistering and premature coating failure.⁵ Maximum recommended permissible concentrations vary considerably for chloride (10-500 mg/m²) and sulfate (100-1000 mg/m²) contamination.² Coating performance will be improved by the use of water to remove salt contaminants. Waterjetting has been shown to remove iron sulfate more rapidly and completely than grit blasting.⁶ Wet blasting techniques both with and without abrasive are more efficient at removing soluble contaminants.

Excessive amounts of water and oil are not easily displaced, absorbed, or transmitted through the film by surface-tolerant coatings and may cause premature coating failure. Some water-tolerant coatings displace water from the substrate and allow the water to pass through the film and evaporate into the air. This is accomplished with hydrophilic solvents and polymers that can displace water effectively. Moisture on the surface or in the pores of the rust will react with the polyisocyanate in the coating. Excess moisture, however, can cause excessive carbon dioxide to be released, causing pinholing, bubbling, and foaming of the urethane film.

Higher film thicknesses of the urethane film may further aggravate this problem. Oil-tolerant coatings are comprised of polymers, which are compatible with oil yet can produce a hard-wearing, resilient coating. Some coatings absorb the oil into the film, forming a gel, while others absorb and pass the oil through the coating. Pooled and visible moisture should be wiped dry with clean rags to the greatest extent possible. Visible oil deposits should be absorbed or solvent cleaned to the extent practicable prior to painting.

Grease deposits are perhaps the most difficult contaminant to paint. Generally, grease cannot be absorbed or displaced by the coating. Painting over grease will impair adhesion and film integrity and should be avoided. Grease deposits should be removed by solvent cleaning prior to painting.

Loose rust and pack rust (rust that has accumulated in joints or crevices) are incompatible with good performance. Rusted substrates should be hand tool cleaned to a tight rust at a minimum. Surface-tolerant coatings should not be applied over loose rust or pack rust.

Much has been written about the overcoating of existing coating systems. This is a particularly popular approach for delaying the removal of hazardous lead-based paints. Overcoating is also employed as a means of upgrading OEM coatings. The primary concern in using surface-tolerant coatings for these applications is coating compatibility. The existing coating must not be lifted or excessively softened by the solvents in the surface-tolerant coating. Strong solvents found in some surface-tolerant coatings such as epoxies and urethanes may cause the existing coating system to fail. In the case of aged coatings, this may be especially pronounced. Good intercoat adhesion between the surface-tolerant coating and the aged or OEM coating is necessary. Refer to ASTM D 5064, "Standard Practice for Conducting a Patch Test to Assess Coating Compatibility." Surface preparation may also affect the performance of the overcoated system. Methods that may disrupt the adhesion of the existing coating to the substrate should be avoided. Brush-off blasting of existing aged coatings has been implicated in the premature failure of surface-tolerant overcoat systems.⁷ Excessive shrinkage of the overcoat may also result in adhesive failure of the old coating. Proper coating selection and the application of test patches prior to overcoating will help prevent premature failures.

Severe exposure environments may also contribute to the early failure of surface tolerant coatings.¹ Situations to avoid include high temperature, frequent or continuous immersion, and exposure to corrosive chemicals.

The name "surface-tolerant coating" implies a certain level of comfort or forgiveness when these coatings are used. While tolerant of relaxations from ordinarily rigorous surface cleanliness requirements, surface-tolerant coatings should be specified with due diligence, as their use is dictated by surface conditions that are known to cause coating failures.

While they are tolerant of surface conditions of which ordinary coatings are not, surface-tolerant coatings also have their practical limits in use.